EXPERIMENTAL STUDIES IN THE PSYCHOLOGY OF MUSIC.

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I. THE ÆSTHETIC EFFECTS OF FINAL TONES.

There are two most important conditions under which the ending of a melody, *i. e.*, of a succession of related tones, has a particular æsthetic effect, an effect of satisfaction, of rest. One of these conditions is the falling inflection (which is effective also in unrelated tones), the other condition is the passing from a tone not represented by a pure power of 2 to a related tone represented by a pure power of 2, when the latter tone has previously been heard or at least imagined. I have elsewhere called this latter effect the tonic effect. The former may be called the effect of the falling inflection.

Some of the peculiar psychological consequences of the effect of the falling inflection are well known to elocutionists. Unfortunately, the matter has never been studied from a purely psychological point of view, important as it is for the psychology of speech as well as of music. I can therefore only briefly point out the difference in psychological effect of the rising and falling inflection in speech. The whole effect may, perhaps, be described as an effect upon the attention of the listener. (I mean here by attention mental activity in general.) A rise in pitch causes the hearer's attention to become strained, and the more so, the steeper the ascent, if I may use this expression. A fall in pitch, on the other hand, causes a relaxation of attention, a cessation of mental activity. No one while asking for any information uses the falling inflection. If he does so, indeed, he may be sure that he will never receive any answer. No one who desires to convince others of some truth with ultimate

success, excluding any further doubt, will use the rising inflection. If he does, he will at once see his hearers shake their heads and show their skeptical attitude. They continue to be mentally active, to keep the matter under consideration.

The same strain and relaxation of attention is to be found in music. The normal end of a mental process is, of course, characterized not by strained, but by relaxed attention; for strained attention means continued mental activity. It is natural, therefore, that a melody ends with a falling inflection. It is not, however, absolutely necessary that a melody end with a falling inflection. The composer may desire to produce the psychological effect of the rising inflection at the end of the melody, and he has the right to produce it.

The other peculiarly satisfactory ending of a melody is the passing from a tone which is not represented by a pure power of 2 to a related tone represented by a pure power of 2, *i. e.*, to a 'tonic.' I have elsewhere[1] applied this tonic effect more in detail to the theory of music.

The most common theory of the satisfactory ending of a melody asserts that a melody, to end satisfactorily, must move from overtones to their fundamental tone. The term 'fundamental' is significant enough in this connection. There is, of course, some truth in this assertion; otherwise it would never have been accepted. But this truth is very imperfect, for there are innumerable cases which it does not explain, and it can be reduced without remainder to the two laws above stated. 1. The fundamental tone is *lower* than its overtones; this is, therefore, a special case of the effect of the falling inflection. 2. The relation of the fundamental to its overtones is a special case of the relation of a tone 2 (using my own symbolization) to a related tone which is not 2, a special case of the tonic effect. One explains a fact scientifically by showing it to be a special case of one or more universal laws. This is what I have done above with the musical effect of the fundamental tone. What is generally found in textbooks is the attempt to explain all musical facts by reference to the special

[1] Contributions to a Psychological Theory of Music, University of Missouri Studies, I, 1, pp. 80.

case of the relation of a fundamental tone to its overtones. Of course, this attempt could not be successful.

The relation of a fundamental tone to its overtones is physically and mathematically so interesting that it is not wonderful that those who have studied the psychological facts but very superficially should have accepted this relation as a satisfactory explanation of all musical facts. I mean in particular the authors of textbooks on physics, some of whom not only present to their readers this superficial æsthetic theory based on fundamental and overtones as an established truth, but even go so far as to ridicule the psychologist who expresses his belief that a few problems in the psychology of music are yet left unsolved.

I will now report the results of a few experiments which clearly show the effect of the falling inflection. The subjects were a number of my students, of both sexes; some more, some less musical (the majority less). Three tones of a reed organ (dulciana stop) were played to them for a few minutes in irregular succession, in order to make the subjects familiar with these tones. After this preparation the actual experiment was begun. The three tones were played a few times in irregular succession, ending on one of them. Then they were played in a similar way, ending on another one; and lastly, ending on the third tone. This was repeated until each subject had made up his mind and written down which of these three endings was the most satisfactory to him. Though the whole number of judgments is but small, the result is characteristic enough.

Two classes of experiments must be distinguished: One in which there was no tonic effect among the three tones; and one in which there were tonic effects. In the former case the three tones were represented by the symbols 3, 5, and 7; in the latter, by 2, 3, and 9. The absolute pitch was always within the range of the human voice. As to the relative pitch, the tones were selected as close together in pitch as was possible in each case; *i. e.*, the three tones of one experiment were always within a single octave. Each of the three tones, however, had an equal chance of exerting its influence, *i. e.*, of being the lowest of the three.

H	7	2	H	5	1	H	3	2
M	3	2	M	7	2	M	5	4
L	5	6	L	3	7	L	7	4

The above little tables show how many times each ending was preferred to the other two possible. L means the lowest tone, M the middle, H the highest. The figures in the second column of each little table are the symbols of relationship. The numbers of the last columns indicate the number of preferences. Since there is no tonic effect in these cases, we may add the preferences for L, M, and H, each without respect to the musical symbols, *i. e.*, without respect to the relationship. We then have the following table:

(I)	High :	5 times,	17 per cent.
	Middle :	8 times,	26 " "
	Low :	17 times,	57 " "

We see a decided preference (57%) for the lowest tone, a dislike for an ending on the highest tone (17%). With this result we must now compare the preferences when the tonic effect is included as a determining factor, as shown in the following tables:

(II)	High	3 :	0 times,	0 per cent.
	Middle	9 :	4 times,	14 " "
	Low	2 :	24 times,	86 " "
(III)	High	9 :	1 time,	4 per cent.
	Middle	2 :	19 times,	70 " "
	Low	3 :	7 times,	26 " "
(IV)	High	2 :	2 times,	7 per cent.
	Middle	3 :	15 times,	54 " "
	Low	9 :	11 times,	39 " "

In table II the lowest tone is the tonic. The combined forces of the tonic and the falling inflection have concentrated 86% of the preferences upon the lowest tone. In table III, where the tonic is the middle tone, it has attracted only 70% of the judgments. In IV, where the tonic is the highest tone, it seems to have lost its peculiar power altogether. However, to explain the distribution of the judgments in IV, we must make use of another psychological effect, which I have also previously emphasized in other publications. In II and III

the three tones are close together; they are all within the limits of a Fifth. As I have elsewhere pointed out, proximity in pitch makes related tones act as a unit, as parts of a psychological whole. The farther apart two related tones are, the less they act as parts of a whole, and the more as separate units; their mutual relationship is less effective. The melody is actually broken up into partial melodies. This is exactly the effect of combining 2, 3, and 9 in such a manner as in IV—9 and 2 are pretty far apart. In II and III the tone 2 was the tonic of the whole, of 9 as well as of 3. But now, because of the distance between 2 and 9, this tonic effect (9-2) has become considerably weaker. The melody therefore falls into two partial melodies, one represented by 9 and 3, the other by 3 and 2. The problem now is not simply which of the three tones shall be at the end, but rather, which of the two partial melodies shall be at the end. This is determined by the falling inflection. The lower partial melody is preferred at the end. And within this partial melody (9-3) its tonic makes its power effective. The tone 3, therefore, receives 54% of the judgments. Hardly any subject seems to care much for the higher partial melody; its tonic receives only 7% of the judgments. But this breaking up of the melodic effect gives the falling inflection an opportunity. The consequence is that the lowest of the three tones attracts a considerable number of the preferences (39%).

The falling inflection has never received from the psychologists the attention which it deserves. Its effects have been noticed, but have not been interpreted as special cases of a general law. It is impossible at present even to attempt to formulate this law. But some one will doubtless some time succeed in doing it, provided that psychologists become aware of the fact that there must be such a law, that these observations in special cases are not unrelated facts, but instances of the effect of a law of some significance. Special observations of this sort are numerous. I shall quote a few from a recent article by Whipple (this *Journal*, XIII (2), April 1902.) p. 231: "B prefers to have V move down; it is easier to react then than when V moves up. In the latter case, there is more strain and nervousness, greater expectation, and a change from the usual method of judgment, much attention being given to the

image." Another special case of this nervousness, set up by the rising inflection, is the muscular effect mentioned in the following, p. 264: "Feelings of tightening and relaxation for 'higher' and 'lower' respectively, were reported throughout the tests with discrete tones, and were also well brought out with the wide differences used in the reaction method."

Now, if a rising auditory sensation causes a peculiar state of attention, of nervousness, should not the reverse effect be possible? Should not a given condition of nervousness tend to raise the pitch of an auditory sensation; of course not of a peripherally aroused sensation, but of a memory image? That such is indeed the case will be seen from the following quotations, p. 240: "Taken with the prevalence of comments by the observers upon the ease with which the position of V is recognized when it does start from below, we find confirmation of the principle upon which we insisted in part I, viz., that for most observers, there is a tendency to sharp the image in the case of a long time interval. . . . The pitch of the auditory image has been gradually raised in the endeavor to maintain it as vividly and clearly as possible." P. 260: "The image apparently tends to flat, but this tendency is more or less consciously resisted by most observers, so that, at least at 30 seconds or afterwards, it is more often sharp." I suspect that the tendency of the image to flat, which Whipple mentions in the latter quotation, is caused by a mental condition opposite to that of nervousness, of continued activity, *i. e.*, by a condition of contentment, of tranquilization, by the dying out of some distinct mental process. Unfortunately, the introspections reported do not mention anything which might clear up this point.

II. The Intonation of Musical Intervals.

In an article by C. Stumpf and the present writer[1] may be found quite a number of facts concerning the intonation of musical intervals. There are, however, some problems left, and some others are suggested by the results of our experi-

[1]Massbestimmungen über die Reinheit consonanter Intervalle. Zeitschrift f. Psychol. u. Phsiol. d. Sinnesorg., XVIII, 1898, pp. 321-404.

ments made in Berlin. On two of these problems I have made further experiments, the results of which are here reported.

1. In an article on the theory of melody[1] I have reported some determinations of the actual intervals which seem to me to have been intended by the composer of a certain melody which we possess merely in the common, unscientific, musical notation. Lipps[2] has raised the objection that I might have been influenced by the experimentally proved tendency to deviate somewhat from the theoretically perfect intonation. I have never regarded this as a very probable source of error, since the deviations to which Lipps refers are not so great as the pitch differences in question. But, in order to decide this question finally, I have undertaken the following experimental investigation.

In my investigations concerning the intonation of certain melodies I always had to choose between two intonations, representing two theoretically different musical intervals. The difference between two such intervals was usually large, 5 or 10 or even more vibrations. From our experiments made in Berlin I knew that the average normal deviation from a perfect interval was never as great as this. However, the question then was a different one. A single interval was presented and the hearer asked if he thought it too large or too small or satisfactory. Now, let us regard a Major Third one vibration too large as subjectively most satisfactory; it is then apriori possible that an enlargement of this satisfactory interval by a certain amount would be less objectionable than a diminution by the same or even a smaller amount; *e. g.*, a Major Third four vibrations too large might be preferred to an interval one vibration too small. If this were true, my method of determining the intonation of melodies would be impracticable. But the result of the experiments made to decide this question was negative.

The subjects were partly professional musicians or amateurs of extraordinarily high musical training and ability, so that

[1] Max Meyer: Elements of a Psychological Theory of Melody. Psychological Review, VII (3), 1900, pp. 241-273.

[2] Lipps: Zur Theorie der Melodie. Zeitschrift f. Psychol. u. Physiol. d. Sinnesorg., XXVII, 1902, pp. 225-263.

they must be classed together with the musicians; partly a number of my students, among whom I selected those who possessed the greatest musical ability. The former class comprised eight individuals who took part regularly in the experiments, the latter about a dozen. In the tables below I give first the results for the former class separately, and then the results for all subjects together.

The intervals used were the Octave and the Fifth. We had found in Berlin that in these two cases the deviations from the objectively perfect interval were particularly great. For this reason I selected these intervals. The tones were a C of about 270 vibrations, its higher Fifth and higher Octave, produced by reeds. The Fifth and Octave were represented by a great many reeds, differently tuned. The intervals under observation were always rising. The experiment was performed in this way: C was sounded, then G; then C again and then another G somewhat higher than the first. The whole experiment was then repeated a second time, and the observers had to write down, which of the two G's they preferred, the lower or the higher one. The given tones appear therefore in the tables always in pairs. The numbers mean the percentage of preferences. The percentage is calculated from a total number of 130 to 160 judgments in each case.

Fifth.

Variations of h. t.	—2	+1	—1	+2	0	+3	+1	+4	+2	+5
Musicians	5	95	29	71	67	33	77	23	95	5
Average mus. indiv's	13	87	40	60	66	34	81	19	94	6

Octave.

Variations of h. t.	—3	+2	—2	+3	—1	+4	0	+5	+1	+6
Musicians	0	100	9	91	55	45	79	21	88	12
Average mus. indiv's	4	96	13	87	43	57	75	25	85	15

The tables show, in perfect harmony with the results of the former (Berlin) experiments, that the subjectively pure Fifth and Octave (rising) are greater than the objectively perfect intervals; the Octave still more than the Fifth. But the answer

to the *new* problem is entirely negative. That is, if we have to choose between two given tones, we select the one which is closer to the subjectively pure interval, no matter in which direction it deviates from this interval.

The objection that experiments on the æsthetically most effective intonation of a melody might be disturbed by a tendency to deviate considerably in one direction rather than a little in the other, must therefore be pronounced unfounded, if the melody consists of two tones only. Now, should we have to assume that considerable deviations in a certain direction are required in a more complex melody, *i. e.*, in a whole system of intervals? Lipps asserts this. A melody, according to Lipps, represents emotions. And deviations from the theoretically perfect intonation are caused, according to him, by a tendency on the part of the hearer to render these emotions as characteristic as possible. If such is the case in a single interval of two tones, how much more in a system of intervals, a melody made up of many tones. Here these deviations, characteristic of the emotions represented by the melody, must be, according to Lipps, extraordinarily great, being the sum of the deviations characteristic of each interval.

I am unable to see either the logical strength of the conclusion, or any empirical foundation for this whole theory. In a single interval a deviation from the theoretically perfect intonation does not cause any disturbance of the conditions of perception beyond the perception of this very interval. But in a melody, the consequence of any deviation is an alteration of every other interval made up by a tone related to the tone which is altered in the first place. This, I should think, is so serious a consequence, that the assumption is more probable, that the tendency to deviate from the theoretically perfect intonation is much weaker in a melody than in a single interval. So far as incidental observation on my part goes, the deviations in a melody are indeed smaller than in a single interval. But I do not wish to assert this positively and make it the starting point for speculation, while exact experimental measurements are yet unavailable.

On the other hand, as to experimental facts, on which this theory of the deviations' being caused by the representation of

characteristic emotions should be based, I do not know any such facts. The facts reported in the following section of this chapter will, on the contrary, perhaps help to convince the reader that the causes of the deviations must be looked for elsewhere than in the supposed representation of characteristic emotions. This theory is merely an hypothesis, in which I do not believe, since I do not see its scientific usefulness.

2. The result of our experiments made in Berlin was that the Major Third, Fifth, and Octave are preferred a little larger than the theoretical intervals; the Minor Third, on the contrary, a little smaller.

Stumpf asserts that under certain conditions a Minor Third a little larger than the theoretical interval is preferred. But I do not agree with him in deriving this conclusion. The table on page 340 of our paper is not a '*Rohtabelle*,' but a very arbitrarily constructed table. The method employed there did not yield any regularity in the results, and in the table, therefore, the reeds producing the variable tone were arbitrarily combined into certain groups. But I am convinced that these groups were too arbitrarily formed to permit any conclusion. This table cannot prove anything. I feel quite sure that the Minor Third is generally preferred somewhat diminished.

The problem now before us is this: *Why* is the Minor Third preferred *diminished*, but the Major Third, Fifth, and Octave *enlarged?* Stumpf has given in our paper, p. 342, an explanation of this fact which I shall prove to be wrong. He has a theory similar to that of Lipps; *i. e.*, the deviations are caused by certain emotions or feelings. The difference between the Major and the Minor Third is thus explained by Stumpf: The Major Third causes a feeling of sharpness, the Minor Third a feeling of bluntness. These two intervals are very common in music. Therefore, when we hear one of them, we cannot help thinking of the other. Now, in general, according to Stumpf's theory, we like all intervals a little enlarged. But in the case of the Thirds, in order to make the characteristic feeling as strong as possible, and prevent its being weakened by the memory image of the other interval, we take the Major Third as large, and the Minor Third as small as possible.

My aim was to find out experimentally whether this expla-

nation of the intonation of the Minor Third was right or wrong. If the intonation of the Minor Third is influenced by the image of the Major Third, by 'contrast,' as Stumpf says, we should notice some difference in intonation proportional to the readiness with which the Major Third is imagined. I therefore made three series of experiments with the same subjects as in the previous section of this paper. In one series I added to the Minor Third the Fifth of the lower tone; in the second series I added the Minor Sixth of the lower tone; in the third series the Octave. The highest tone was sounded first; then the lowest and last the variable tone representing the Minor Third. The subjects knew that only the third tone was variable. The procedure was exactly the same as described in the experiments on the Fifth and Octave.

Minor Third plus Fifth.

Variations of Third	—3	0	—2	0	—1	+1	—1	+2
Musicians	15	85	33	67	64	36	96	4
Average musical individuals	28	72	47	53	61	39	90	10

Minor Third plus Minor Sixth.

Variations of Third	—3	0	—2	0	—1	+1	—1	+2
Musicians	13	87	20	80	56	44	98	2
Average musical individuals	22	78	35	65	53	47	91	9

Minor Third plus Octave.

Variations of third	—3	0	—2	0	—1	+1	—1	+2
Musicians	26	74	30	70	73	27	96	4
Average musical individuals	24	76	22	78	60	40	88	12

No one who has any musical experience will deny that our readiness to think of either of the Thirds is very great when we begin each experiment by sounding the Fifth or the Octave. But if we begin with the Minor Sixth and then hear the lower tone, there is a strong expectation of the Minor Third; but no expectation at all of the Major Third unless we

have just returned from Bayreuth. We should find, therefore, in accordance with Stumpf's theory of contrast, that a diminished Minor Third is preferred in combination with the Fifth and Octave, an enlarged one in combination with the Minor Sixth. The tables do not show anything of the kind. The only difference found is this, that the preference of a diminished interval is slightly less in combination with the Sixth than with the Fifth and the Octave. But this difference is so small that it is safe to attribute it to chance. We then reach this conclusion: The 'contrast' of which Stumpf speaks may have, under certain circumstances, a slight influence upon the intonation of the Minor Third; but *contrast is entirely inadequate for explaining* the fact that a diminished Minor Third is generally preferred. And then, we may go a step farther and conclude that the whole theory (of Lipps as well as of Stumpf) explaining the facts of intonation by characteristic feelings is mere fancy.

It is often interesting to note the extent to which a speculative theory is influenced by the usage of language. It is merely an *historical* fact that the intervals 5: 6 and 4:5 are both called Thirds, the one Minor, the other Major. If we count the semitones, it is perfectly justifiable to call the interval 5: 6 a 'Third' and the interval 4:5 a 'Fourth.' If, historically, the latter nomenclature had been accepted, no one, most probably, would ever have thought of explaining differences of intonation by contrast. But since these intervals are accidentally called Minor and Major Thirds, there must be, of course, 'contrast' between them!

After we have broken down let us reconstruct. The intonation of the Minor Third and the intonation of the other three intervals seemingly do not obey the same law! But why not apply a little mathematical thought? We found in Berlin that the deviation of the Octave is very great, of the Fifth less, of the Major Third the least. Is it not perfectly natural, under these conditions, to assume that the curve representing these facts passes through *zero* below the Major Third? Then, of course, the deviation of the Minor Third must be of a negative sign, as it actually is. Now, this is not offered as a mere hypothesis, but I shall prove that it is true. If the sign of the

deviation of the Minor Third is negative, we shall expect it to be negative also in the case of any yet smaller musical interval, and the absolute amount to be correspondingly greater.

I selected for experimentation the smallest interval of two related tones, the Semitone (15:16). The subjects were three, Prof. A., B., and the writer. A. and B. are amateurs of exceptionally high musical abilities. A. plays the piano and the organ and is also theoretically trained; B. plays the violin and has a memory for absolute pitch. The tones were produced by reeds of 403 and 448 vibrations and a number of reeds between. 403 was the starting tone for the rising interval, 448 for the falling interval. The interval 15:16 is represented by 430 in rising, by 420 in falling. For the judgment, each interval was given twice, with a short pause between. The writer (when serving as subject) knew of course the intervals used, but not the order in which they were offered for judgment. The other two subjects knew nothing and suspected nothing about the objective conditions of the experiments.

Semitone, rising.

Variation of the higher tone	Actual number of Judgments.			Judgments per cent.		
	—	0	+	—	0	+
— 5	0	0	9	0	0	100
— 6	0	5	16	0	24	76
— 7	7	9	5	33	43	24
— 8	10	20	3	30	61	9
— 9	22	11	0	67	33	0
—10	31	1	1	94	3	3
—11	20	1	0	95	5	0
—12	12	0	0	100	0	0

In spite of the fact that the writer knew that all the intervals were objectively too small, no difference was found between his judgments and those of the other two subjects. The judgments of all three are therefore added together. The minus-sign under the head of 'judgments' in the table means that the interval was declared too small, the plus-sign that it seemed to be too large. 0 means that the interval was satisfactory. It is astonishing to see how much a rising semitone must be diminished in order to be satisfactory. In the case of −5 the subjects repeatedly stated their dissatisfaction in very strong

terms, saying that it sounded almost like a whole tone. This fact shows how unsuspecting the other two subjects were, particularly in connection with the fact that each series with rising intervals was made in the same hour and following after a series with falling intervals, among which the perfect interval 15:16 frequently occurred and therefore was actually heard. That these subjects were perfectly normal, with respect to the Major Third, Fifth, and Octave, had been found in the other series of experiments. It can also be seen from the following tables showing the judgments of the same three subjects on the intonation of the Fourth and the Major Sixth. They preferred all intervals above the Major Third enlarged, and the more so, the greater the distance represented by the interval. No experiments were made by us in Berlin on the Fourth and the Major Sixth. That these intervals obey the same general law is proved by the tables.

Fourth, rising.

Variation of the higher tone.	Actual number of Judgments.			Judgments per cent.		
	—	0	+	—	0	+
—1.0	11	1	0	92	8	0
—0.5	15	3	0	83	17	0
0	18	3	0	86	14	0
+0.5	11	7	3	52	33	15
+1.0	5	11	5	24	52	24
+1.5	3	4	14	14	19	67
+2.0	2	4	15	10	19	71
+3.0	0	1	14	0	7	93

Major Sixth, rising.

Variation of the higher tone.	Actual number of Judgments.			Judgments per cent.		
	—	0	+	—	0	+
—1.0	12	0	0	100	0	0
—0.5	17	1	0	94	6	0
0	19	2	0	90	10	0
+0.5	19	2	0	90	10	0
+1.0	11	10	0	52	48	0
+1.5	3	13	5	14	62	24
+2.0	0	16	5	0	76	24
+3.0	4	2	9	27	13	60

We may therefore state it as an established law that the

smaller musical intervals are preferred diminished, and the more so the smaller the distance represented by the interval; that the larger musical intervals are preferred enlarged, and the more so the greater the distance represented by the interval; and that the point where the curve of the deviations passes through zero, is situated between the Minor and Major Thirds. But we must add a condition to the formulation of this law: namely, the interval must be a *rising* interval.

This condition could have been derived with some probability from the experiments made in Berlin. It is clearly proved by the following table.

Semitone, falling.

Variation of the lower tone.	Actual number of Judgments.			Judgments per cent.		
	—	0	+	—	0	+
—2	1	1	34	3	3	94
—1	2	1	33	5	3	92
0	3	19	14	8	53	39
+1	11	22	3	31	61	8
+2	24	11	1	67	30	3

The preference of a diminished interval is extremely slight in comparison with the same rising interval. The falling semitone-interval, in which the lower tone was sharpened by one vibration, rendering the interval one vibration too small, was declared in 61 % of the cases satisfactory. But this deviation from the theoretically perfect intonation is insignificant, when compared with the deviation of eight vibrations in rising. We must, therefore, add to the above formulation of the law the condition that this law holds good only for rising intervals. A possible explanation of the small deviations in falling intervals may be found in the fact that sometimes, in order to judge, we call up a memory image of the first tone and thus change the falling interval into a rising one.

I have thought of the question whether the effect of the rising and falling inflection which we have discussed above might have any causal relation to the difference of deviation in the rising and falling intervals. I am unable, however, to establish any causal connection between these facts.

III. Quartertone-Music.

By 'quartertone-music' I do not mean music which strictly speaking is made up of quartertones; but any music which contains intervals considerably smaller than a semitone. Such small intervals are usually called quartertones. Music of this sort is very common among Asiatic peoples. Numerous writers have pointed out this fact, but no attempt has ever seriously been made at a psychological theory of this music. One certainly cannot designate as an attempt at a theory the simple assertion that quartertone-music is based on psychological laws fundamentally different from those forming the basis of other music—the assertion that not the melodic relationship, but the proximity of pitch is the psychological condition of the æsthetic effect of such music. I have elsewhere expressed my conviction that the fundamental psychological laws of music are the same all over the world. The modern progress of anthropological investigation has already overthrown many a prejudice concerning differences in the congenital psychological organization of the different races of man. I am convinced that the result will be the same with regard to music, as soon as the theoretical study of music shall have become less superficial and artificial, less speculative and more psychological.

In order to contribute something towards a better understanding of quartertone-music, I made up such music, following the same laws which I had found by analysis of our common music; but with this difference that I did not interrupt the procedure whenever a quartertone resulted, but on the contrary included some quartertones. The problem was to describe the æsthetic effect of this music at the first hearing and later when it had become more and more familiar. The music was a melody plus a harmonization, as seen from the following table.

9	9	35	135	135	75	9	15	27	105	405	27	15	15	35	135	135	15
15	15	15	15	225	15	15	45	45	45	45	45	45	21	15	15	225	45
45	21	5	45	45	45	45	135	135	75	135	135	9	9	5	45	45	75
						15	45	45	15	405	45						

.01 E.S.:		204		63		49		70		112		85		119		204		63		49		70		112	
Symbol:	15		135		35		9		75		5		21		45		405		105		27		225		15

The first line of the above table represents the melody, which I first made up. The following three lines represent the harmonization, which I added to the melody. The last two lines represent (within a single octave) all the tones used, arranged according to pitch. The last line contains the symbols which I have introduced for the theoretical notation of music. The line above the last shows the distance between each succeeding pair of tones of the series, measured in hundredths of an equally tempered semitone (E. S.). I have added this line in order to prevent any reader from attempting to repeat my experiments by playing the above music on the piano. This is impossible, since only a few of the intervals are approximately equal to one or two semitones; most of them are much smaller, and two are almost exactly equal to a quartertone (.49 E. S.).

I played this music on a reed organ, which was perfectly tuned in what I have called the Complete Musical Scale up to a convenient limit. I first played the melody unharmonized to myself. The æsthetic effect (I shall first describe the observations without any attempt to explain them) was highly disagreeable. I then played the melody plus the harmonies. The æsthetic effect was not agreeable, but not by any means so disagreeable as when I played the melody unharmonized. I then played the whole piece a few times every day for a couple of weeks and noticed that gradually it lost all its disagreeableness and became more and more beautiful; at the same time I noticed that the more I committed the music to memory, the better became the æsthetic effect, until, when I expected the tones of each chord before I heard them, no dislike of any of the tones heard remained. I now played again the unharmonized melody and found that the æsthetic impression was very different from the one I had had at the first hearing. (The music was made up entirely by theoretical means, without the use of the ear.) Although there was no particular beauty to speak of, as in the harmonized piece, there was no disagreeableness left. It sounded simply commonplace.

I then experimented on a considerable number of other individuals. I told them that I would play to them some music of an unusual character (but did not tell them any further details) and asked them to answer the following questions:

"Does this music seem to be of a familiar type or does it sound strange? If familiar, tell of what sort of music it reminds you. If strange, tell what distinguishes it from music you are familiar with (1) theoretically, (2) in its emotional effect. Tell, further, whether the first hearing impressed you differently from the last.

The questions were somewhat indefinite, because I did not wish to make any suggestion as to my real problem (the effect of quartertones); consequently some of the answers referred to matters with which we are not concerned. The answers are reported in the following only so far as they refer to the present problem. I played the harmonized piece very slowly a dozen or fifteen times. Fourteen subjects took part in this experiment. In parentheses, after the names of the subjects, their musical specialty, if any, is indicated; subjects from the student body are indicated by the word "student."

Prof. H. B. Almstedt (piano, organ): The chords seem familiar and strange. The emotional effect was pleasing, save in a few instances.

Mr. W. G. Bek (student): I liked the last playing better than the first, very much more so.

Mr. H. Borgstadt (student): Strange. First impression better than last.

Mr. C. C. Crouch (student): The music seemed different from any I am familiar with. At first it seemed unpleasant, at last it became pleasant or at least not unpleasant. The emotion it aroused seemed to be sorrow.

Mr. W. Higbee (student): It sounds like a funeral dirge. It seems to have occasional errors in harmony and has some discords, apparently. Its emotional effect is as a dirge. The effect gets more pleasing as it progresses. The general tone seems to be foreign, like we usually hear on 'Midway' in front of 'Streets of Cairo.' The scale seems different.

Miss L. Hoffman (student): It sounds strange because the successions are so unexpected. When I heard the first chord, it reminded me of something I had heard somewhere, and I had a vague idea of what could follow it, and when it did not, then it sounded strange. I believe I liked it best the last time it was played.

Mrs. C. Jones (voice): Sounds unfamiliar. Some of the chords suggest Grieg in their weird strains. More pleasing at the last than in first hearing.

Mr. R. Kern (student): It sounds strange. The emotional effect is sadness. The chords do not seem to be made up of closely related tones.

Miss C. Kerr (piano): If by type you mean the chord progression, it sounds strange. Suggests a German Choral in minor. It is not our scale. It is weird like a barbaric funeral chant.

Miss C. U. Mills (piano, organ): Is pathetic on account of the predominance of minor.

Mr. H. T. Moore (student): This music is not exactly familiar or entirely strange. Some of the intervals come in in rather unexpected succession. I liked the last better than the first, because I became more used to the succession of chords.

Prof. F. H. Seares: First impression more pleasing, decidedly, than last.

Prof. T. C. Whitmer (piano, organ, composition): It is music not familiar to the average ear. It belongs to the mediæval modes, and therefore it possesses no tonality. The oftener it is played the more beautiful it becomes. We are not accustomed to the limitations in scale, such as is here represented.

Miss A. Zimmerman (student): Sounds strange. It is too weird for church music and not martial either. It sounds like some Arabian music I heard in 'Buffalo Bill's Wild West Show.' The first time was disagreeable because of what seemed like discords. But it becomes much more pleasant in the last till it is fascinating.

To sum up the results, let me say, that of the fourteen subjects eight declare that the æsthetic effect is improved by hearing the music repeatedly. Four do not mention any such difference at all. Only two (not especially musical) subjects declare that the first impression was better.

A fortnight later I repeated the experiment, but now told the subjects that the music contained quartertones, to which I called their attention. Some of the former subjects were not present this time, but there were some new ones.

Mr. W. G. Bek (see above): The whole sounded rather pleasing to me at the first playing, but grew more and more pleasing toward the end. There is something in the music that gives me a sort of *Andachtsstimmung*. It did the other time and does even more so this time.

Mr. H. Borgstadt (see above): The music is not altogether unfamiliar. Some parts sound like some sacred music that I have heard Some parts sound well, others not so.

Prof. W. G. Brown: The music suits me. I am used to and enjoy the drone of the bagpipe. Not only am I reminded of this, but I am forced to remember some of Wagner's operas, I think parts of Lohengrin. I am, however, forcibly impressed by its stately, not to say churchly character. I enjoy such music extraordinarily well.

Mr. D. Burnet (violin; good observer, but generally much inclined

to theorizing while serving as subject): Does not sound so bad at the end as at first. Seems to me, though, that this is because the ear becomes indifferent, and I do not believe I could ever come to enjoy music built on such a scale. Some of the harmonies are not unpleasing and some of the discords not impossible. But some of the intervals sound so impossible that I do not believe they would ever be bearable.

Mr. F. C. Donnell (student): Sounded weird, like a funeral dirge; but instead of sounding bad, it sounded good to me—really pleasing. The more I heard it, the better it sounded.

Miss L. Hoffman (see above): Some parts of it very pretty, other parts weird. Most of the ideas it suggested were pleasant.

Mrs. C. Jones (see above): Better as it grows more familiar.

Miss C. Kerr (see above): It does not sound so objectionable to-day.

Miss C. U. Mills (see above): It seems to be a fact that the example grows more endurable.

Prof. T. C. Whitmer (see above): Undoubtedly the music becomes much more beautiful on acquaintance. The new sensations of the quartertones become most agreeable with frequent repetitions, let me repeat.

Miss A. Zimmerman (see above): The music loses its discordance and gets very pleasant and fascinating. It is so new and different.

Of the eleven subjects eight had been present the other time. Five of them confirm their former observation that the æsthetic effect increases with familiarity. Two who did not express any opinion on this point before make now the same observation. Of two subjects who declared that the first impression was better, one is now absent, the other does not state again that the æsthetic effect is getting worse. The three new subjects agree with the rest in observing that familiarity increases the æsthetic effect.

A fortnight later I made a third experiment, most of the subjects of which had heard the harmonized piece either once or both times before. One only heard this quartertone-music now for the first time. I played alternately the melody accompanied by a single bass tone (15 in the first and third, 45 in the middle part) and unaccompanied. The subjects were requested to compare the æsthetic effect of the one case with that of the other.

Prof. H. B. Almstedt: I prefer the double to the single series. The bass seems to veil the disagreeable less-than-half-tone sequence of the single series.

Mr. W. G. Bek: I do not like the melody as such. In connection with the accompaniment it sounds better.

Mr. H. Borgstadt: When the series is accompanied by another tone it sounds better than when played alone.

Prof. W. G. Brown: Better when accompanied by another tone. It seems out of tune at certain parts when the melody alone is played, which out-of-tune places are more or less pleasantly modified when accompanied.

Mr. F. C. Donnell (had heard it only once before): I like it better when the other tone is not sounded with it. I would not recognize either as being worthy of the name of a tune, although I enjoyed it last week when it was accompanied by full chords.

Mrs. C. Jones: I prefer the combination with other notes, rather than the simple tones.

Mr. R. Kern: I like it very much more with the additional tone. Some of the notes seem out of tune. This is much less noticeable with the extra tone. I rather like the melody with the extra tone.

Miss C. Kerr: I prefer it either alone or fully harmonized. It is *entsetzlich* with the second tone.

Miss C. U. Mills: Some of the intervals are too small to be acceptable. (No definite answer to the question given.)

Dr. Caroline Stewart (new subject): Better alone; alone somewhat out of tune, with a second tone more out of tune.

Prof. T. C. Whitmer: I prefer the melody played with the second melody. Sounded alone, the melody seems more out of tune. Less relationship among the tones is apparent when the melody is played alone.

It is of the utmost importance to notice that those subjects who had come to enjoy the harmonized piece more or less, preferred the melody accompanied by a bass, whereas those who had not arrived at familiarity with the harmonized piece, preferred the melody unaccompanied by a bass.

From my own introspections and those of the other subjects I draw the following conclusions. Tones in the interval of a quartertone are unrelated, but there is no psychological law excluding, for this reason, quartertones from being used musically; in our common music, also, tones are sometimes used which are not directly related. Tones forming the interval of a quartertone may be used musically if both are related to a third tone appearing in the music. That we do not enjoy at once every tone combination with which we are unfamiliar is a well known fact. Even Beethoven's works were not enjoyed at once by every one, but, on the contrary, very severely criti-

cized by some. But the fact that mere familiarity with quartertone-music makes it possible for us to enjoy such music, proves that the fundamental laws of quartertone-music cannot with any probability be assumed to be different from those of any other sort of music.

The individual differences observed can be explained without any difficulty. 1. Some individuals by their congenital mental constitution like music which is atonic and made up of less closely related tones better than other individuals do. There were some subjects who liked the quartertone-music almost from the start. 2. Some individuals have acquired a strong habit of thinking musically, and of course in music with which they are familiar. Quartertone-music must naturally be 'out of tune' to them, because it overthrows all their firmly established habits of musical thought; and it takes them a long time to establish new habits of musical thought, including these new combinations of tones.

The melody used in the above experiments is one which is not very readily appreciated. It is not very melodious. The first tone 35 is (if unaccompanied) very far away from any related tone (the first one is 15). If we add to it a bass which is related to 35, we should expect the tone 35 to exert more readily its æsthetic capabilities. Most individuals, therefore, preferred the melody when accompanied by a bass, to the same when played alone. But why did a few still prefer the melody unaccompanied? It is not difficult to explain these exceptions to the rule. If, for any reason, we *expect* some other combinations of tones than we hear, we most readily perceive the tones simply as *mistuned* combinations of the sort we expect. It is by no means impossible to be æsthetically affected by a piece we are familiar with, if it is played on a very mistuned instrument. But if now the bass is added, this acts as a strong factor, compelling the hearer to perceive the relationships as they actually are. Then this music is '*entsetzlich*' because it violates the habit of the hearer who cannot help expecting tone combinations of another sort. This explains very well the exceptions which we find among the records.

Let me state again, from another point of view, the causes why quartertone-music is not usually at once appreciated. 1.

We *do not like* it (we are neutral), because, the music being new to us, the relationships are not sufficiently effective. 2. We *dislike* it, because, from our musical habits, we expect something else. But, of course, occupation with something indifferent turns after a few moments into positive dislike; *i. e.*, dislike is the final result of either condition.

I should like to know, then, the facts compelling us to assume that the quartertone-music of oriental peoples is based on psychological laws fundamentally different from the laws of our common music! If we can make up quartertone-music by merely applying the laws of our common music, and if the conditions of our appreciation of this quartertone-music are such as above described, is it not highly probable that the same laws can be applied also to that quartertone-music which we actually find among foreign nations?